# MATH35072 - 2012/2013

### General Information

- Title: **Mathematical Modelling and Reactive Flow**
- Unit code: MATH35072
- Credits: 10
- Prerequisites: None
- Co-requisite units: None
- School responsible: Mathematics
- Members of staff responsible: Dr. Joel Daou

# Specification

## Aims

The course introduces basic modelling concepts and methods to study multi-disciplinary problems involving transport phenomena and reactive flows. The skills to be gained are of quite general applicability and are highly valuable for tackling a variety of practical and research problems, encountered e.g. in the automobile and aeronautic industries, the energy production sector, and the field of environmental pollution.

## Brief Description of the unit

We introduce the governing equations which describe the transport of mass, heat, and momentum in a variety of important applications such as car engines. The resulting mathematical problems, such as those describing flame ignition, propagation and extinction, say, often involve small or large parameters, and wide variations in scale. Techniques used in boundary-layer theory, such as non-dimensionalisation, scaling, and asymptotic approximation and matching, were developed to help obtain good approximate solutions for such non-linear problems. The course will introduce the basic ingredients to model such systems, including techniques for determining relevant solutions and their stability.

## Learning Outcomes

On successful completion of this course unit students will be able to formulate and solve methematical models involving transport phenomena and reactive flow.

## Future topics requiring this course unit

None

## Syllabus

- Governing equations describing transport phenomena and chemically reacting flows.
- Interfacial boundary conditions.
- Introduction to singular perturbation methods with applications.
- Heat and mass transfer in unidirectional flows.
- Chemical reactors and stability: Ignition and extinction phenomena; distinguished asymptotic limits.
- Premixed Flames: Travelling waves in reaction-diffusion systems; matched asymptotic analysis; jump conditions and their use.
- Mixing problems and diffusion-flames. Passive scalars and the Burke-Schumann fast chemistry limit. Evaporation and Combustion of droplets.
- Stability analysis in reaction-diffusion systems. Several examples including the stability of travelling waves describing flames.

## Textbooks

- R.S. Brodkey and H.C. Hershey, Transport Phenomena, McGraw-Hill 1989.
- J. C. Slatery Advanced Transport Phenomena, Cambridge University Press1999.

- F A Williams, Combustion Theory, (2nd Edition), Benjamin Cummins 1985.
- J D Buckmaster and G S Ludford, Theory of Laminar Flames, Cambridge University Press 1982.

### Teaching and learning methods

Two lectures and one examples class each week. In addition students should expect to spend at least four hours each week on private study for this course unit.

### Assessment

One coursework worth 20%

Two hour end of semester examination; weighting within unit 80%

## Arrangements